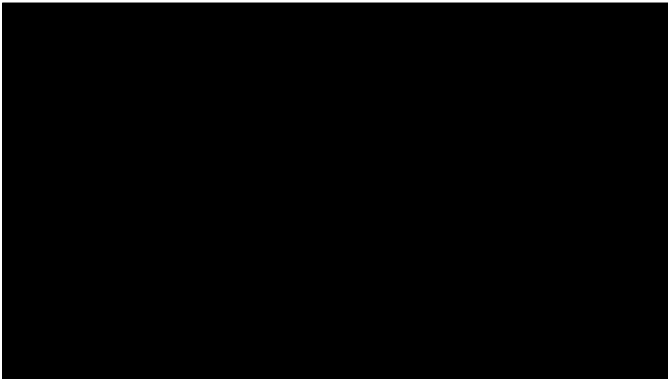




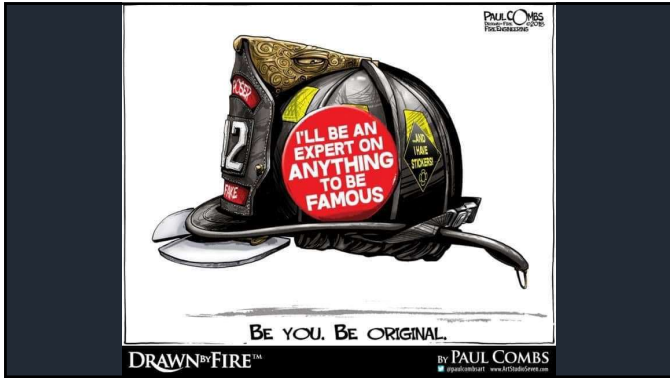
1



2




3



4



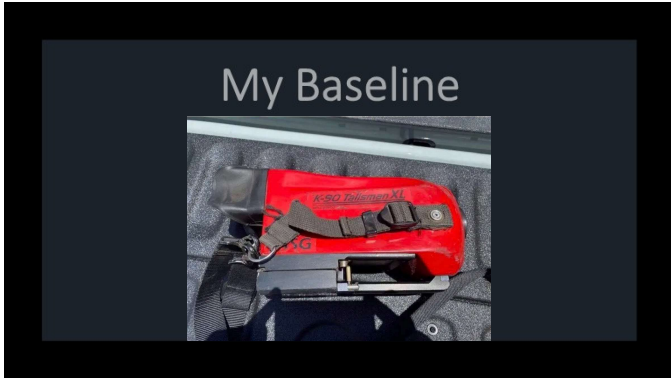
5



- Who taught you?
- When were you taught?
- How were you taught?
- What did you learn on vs use?
- Where were you trained?
 - Classroom?
 - Training smoke?
 - Live fire?

What Is Our Baseline?

6



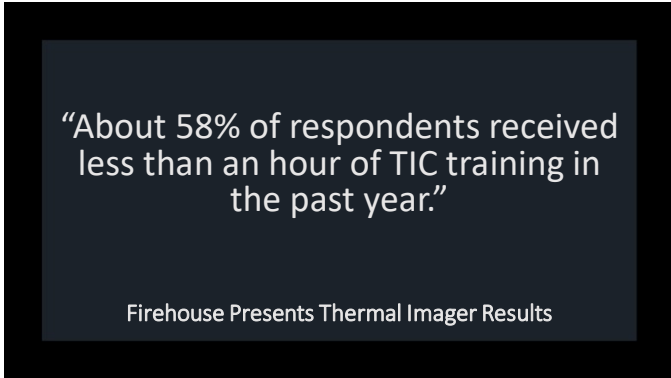
7



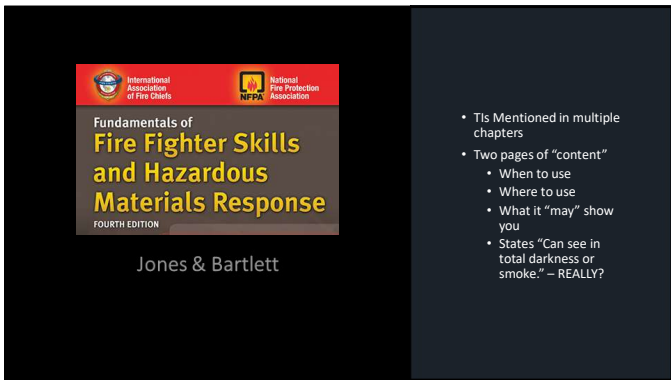
8



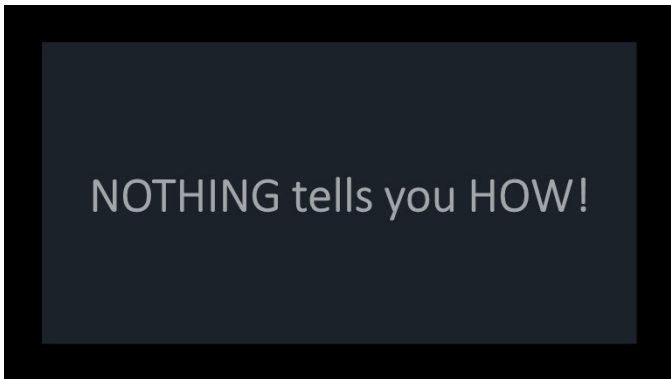
9



10





11



12

2020 NFPA 1408 – Standard For Training Fire Service Personnel on the Operation, Care, Use, and Maintenance of Thermal Imagers

 6.1.1 Prior to being permitted to participate in the TI training program, students SHALL have received training to meet the JPRs for Firefighter 1 in NFPA 1001 or NFPA 1081.

 6.1.1.2 Students who have not yet met the requirements of 6.1.1 SHALL be permitted to participate in cognitive-based TI training to obtain knowledge of basic TI technology and operation.

13

2024 NFPA 1010: 7.3.3
Standard on Professional Qualifications for Firefighters

- Operate a thermal imager (TI), given a TI, SOPs, PPE, and an assignment, so that victims are located in conditions of obscured visibility, hot spots are identified in a structure, overhaul is completed, and the liquid level in a container is determined.
- (A) Requisite Knowledge.
 - TI operating procedures and limitations of TIs.
- (B) Requisite Skills.
 - Demonstrate the use of a TI and accurately interpret TI data to locate victims, fire, hot spots, and liquid levels in containers.

14

2020 NFPA 1408: 7.1.1
(NFPA 1408 is now NFPA 1400)

- All participants using TIs *shall* understand their use and limitations along with scientific principles describing the operation of the TI.

15



- Infrared cameras are non-contact devices that detect thermal energy and then convert it into an electrical signal, which is then processed to produce an image. – Teledyne FLIR

16

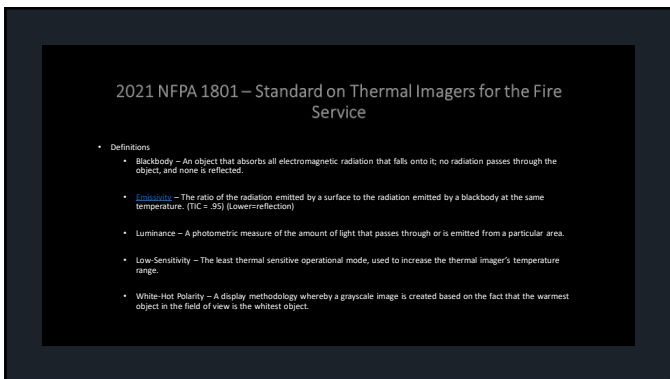


2021 NFPA 1801 – Standard on Thermal Imagers for the Fire Service (now NFPA 1930)

#1 NOT ALL THERMAL IMAGERS ARE NFPA COMPLIANT/CERTIFIED

- NFPA intent is to standardize for durability, safety, and ease of use

17



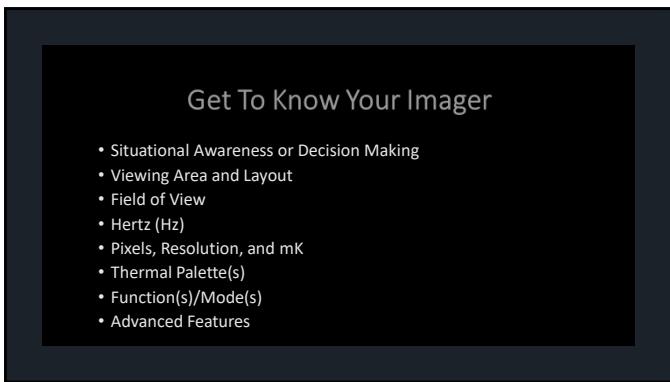
2021 NFPA 1801 – Standard on Thermal Imagers for the Fire Service

- Definitions
 - Blackbody – An object that absorbs all electromagnetic radiation that falls onto it; no radiation passes through the object and none is reflected.
 - Emissivity – The ratio of the radiation emitted by a surface to the radiation emitted by a blackbody at the same temperature. (TC = .95) (Lower=reflection)
 - Luminance – A photometric measure of the amount of light that passes through or is emitted from a particular area.
 - Low-Sensitivity – The least thermal sensitive operational mode, used to increase the thermal imager's temperature range.
 - White-Hot Polarity – A display methodology whereby a grayscale image is created based on the fact that the warmest object in the field of view is the whitest object.

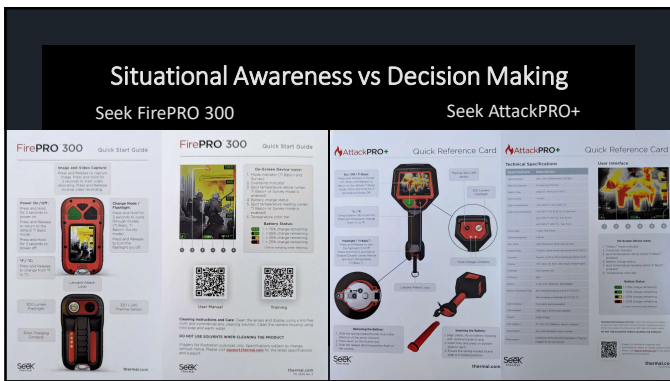
18



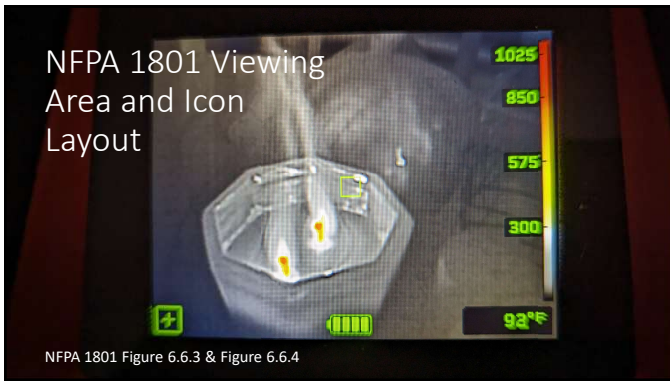
19



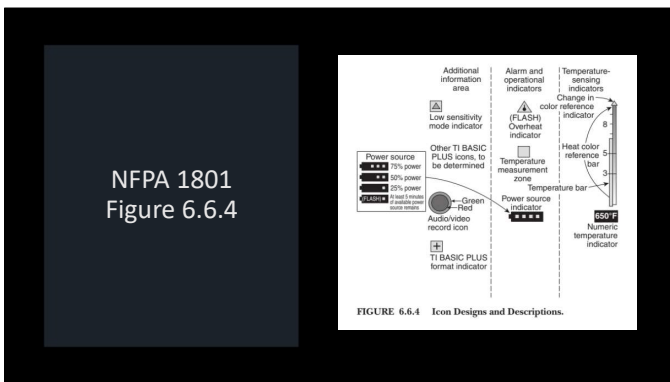
20



21



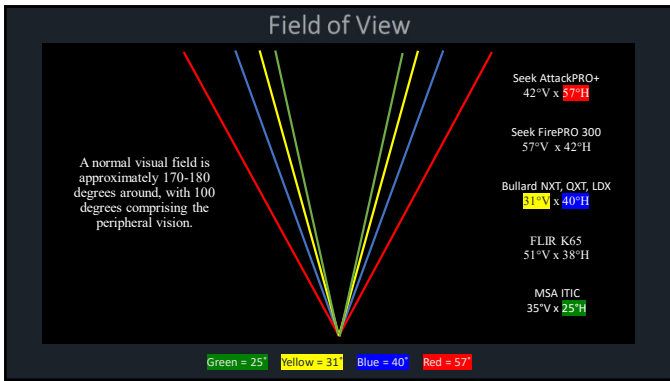
22



23



24



25



26

Hertz (Hz)

- Most people see 20-60 Hz
- The higher the rate, the less "flicker" or "lag"
- 60 Hz is roughly 60 frames per second (debated)
- Most movies are 24 frames per second (FPS)
- If a TIC is 9 Hz, we will likely see flicker and lag

Flir K2 = 9Hz

MSA ITIC = 9Hz

MSA 5200 = 30Hz

27

Hertz (Hz)
isn't
EVERYTHING

- What is the Processor Speed?????



Test them side-by-side

28

Pixels,
Resolution,
& mK

WHY DO WE CARE?



Flir K2
160x120=19,200

MSA ITIC
220x176=38,720



Bullard NXT
Seek FirePro300
Flir K65
Seek Attack PRO+
320x240=76,800
Bullard QXT Pro -
640x480

29

How does a TI
Measure/See Heat?

30

TIs Show Surface Heat

31

Thermal Palette & Modes

- Palette – How Temp is assigned to pixel color
- Gain – Modes of sensitivity

Understanding Temperature Modes

Single Gain	+	Search & Record Mode, Survey Mode, Thermal Data, Database Mode
256 Gain	+	ELI HOT sensor
768 Gain	+	Scott V300, Leukos 8 Plus
Mixed Gain	+	No resolution: 640x Thermal, MSX, etc. MSX 128x82, Scott V322

https://www.firetrains.com/photos/780a-9235289075475&utm_source=12118128-4340734

32

33



34

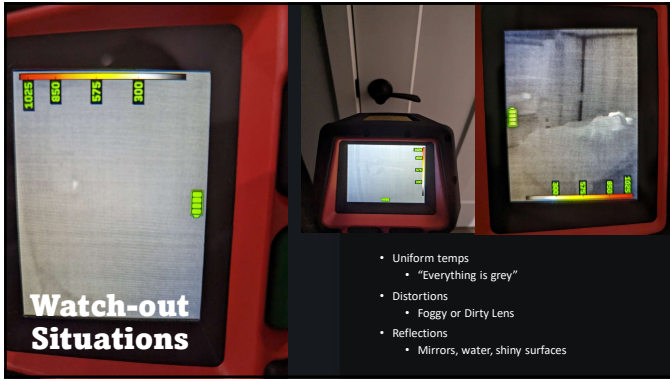


35

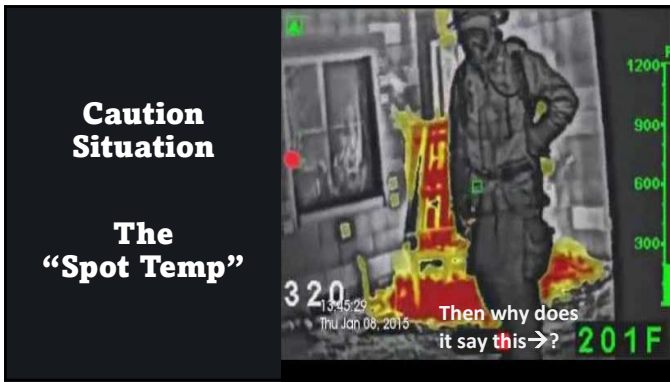
NFPA 1408
Image
Information &
Misinformation

1. Distance and recognition dependent on environment
2. Image Clarity (rain, snow, heat, etc)
3. Image Compromised by Depth Perception
4. Reflectivity – (mirrors, puddles, shiny surfaces)
5. Ability to “see” through windows is dependent on the IR sensor, glass type, and thermal conditions
6. False readings
7. Emissivity and contrasts between objects
8. Water (reflective image)

36



37



38



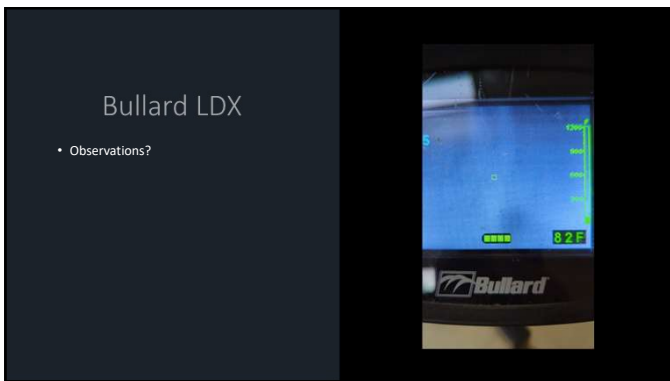
39



40



41



42

Bullard NXT (NFPA)

- Decision Making
- Field of View - 31°V x 40°H
- Resolution – 320 x 240
- Hertz (Hz) - 60
- Thermal Palette(s) – “Super Red Hot”
- Function(s)/Mode(s) – “Electronic Thermal Throttle”



43

Bullard QXT

- Decision Making
- Field of View - 31°V x 40°H
- Resolution – 320 x 240
- Hertz (Hz) - 60
- Thermal Palette(s) – “Super Red Hot”
- Function(s)/Mode(s) – “Electronic Thermal Throttle”



44

Bullard QXT PRO & NXT PRO

- Decision Making
- Field of View - 31°V x 40°H
- Resolution – 640 x 480
- Hertz (Hz) - 60
- Thermal Palette(s) – “Super Red Hot”
- Function(s)/Mode(s) – “Electronic Thermal Throttle”
- User Changeable Colorization



45

Bullard T3Max

- Decision Making
- Field of View - 37°V x 50°H
- Resolution – 160x120
- Hertz (Hz) - 30
- Thermal Palette(s) – “Super Red Hot”
- Function(s)/Mode(s) – “Electronic Thermal Throttle”



46

Bullard T4

- Decision Making
- Field of View - 32°V x 50°H
- Resolution – 320x240
- Hertz (Hz) - 30
- Thermal Palette(s) – “Super Red Hot”
- Function(s)/Mode(s) – “Electronic Thermal Throttle”



47

MSA LUNAR

- Observations?



48

Seek FirePRO 300


- Awareness
- Field of View - 57°V x 42°H
- Resolution – 320 x 240
- Hertz (Hz) – 25
- Thermal Palette(s) –
 - TI Basic, TI Basic +, Survey
- Sensitivity
 - <35 mK w/ SV1
- 300 Lumen Flashlight
- Photo & Video Capability



52

Seek Attack PRO +

- Decision Making
- Field of View - 42°V x 57°H
- Resolution – 320 x 240
- Hertz (Hz) – 25
- Thermal Palette(s) –
 - TI Basic, TI Basic +, (VRS has Survey)
- Sensitivity
 - <35 mK w/SV1
- 300 Lumen Flashlight
- (VRS has Video Capability)



53

Flir K1

- Awareness
- Field of View - 57°V x 44°H
- Resolution – 160x120 w/MSX
- Hertz (Hz) – 8.7
- Thermal Palette(s) –
 - TI Basic, WH, Iron
- Sensitivity
 - <100 mK
- Photo Capability



<https://www.flir.com/products/k1/?vertical=public+safety&segment=solutions>

54

Flir K2

- Awareness
- Field of View - 47°V x 35°H
- Resolution – 160x120 w/MSX
- Hertz (Hz) – 9
- Thermal Palette(s) –
 - TI Basic
- Sensitivity
 - <100 mK
- Photo Capability




<https://www.flir.com/products/k2/?vertical=public+safety&segment=solutions>

55

Flir K33

- Decision Making(ish)
- Field of View - 51°V x 38°H
- Resolution – 240 x 180
- Hertz (Hz) – 60
- Thermal Palette(s) –
 - TI Basic
- Sensitivity
 - <40 mK
- Photo Capability



<https://www.flir.com/products/k33/?slide=flir-k33-51x38-60hz-240x180-40mK-TI-Basic-CuAUL0mRZ0FbM8NM6IBq>

56

Flir K45

- Decision Making
- Field of View - 51°V x 38°H
- Resolution – 240 x 180
- Hertz (Hz) – 60
- Thermal Palette(s) –
 - TI Basic, Black & White, Fire, S&R, Heat Detection
- Sensitivity
 - <40 mK
- Photo Capability



<https://www.flir.com/products/k45/?vertical=public%20safety&segment=solutions>

57

Flir K55/65

- Decision Making
- Field of View - 51°V x 38°H
- Resolution – 320 x 240
- Hertz (Hz) – 60
- Thermal Palette(s) –
 - TI Basic, Black & White, Fire, S&R, Heat Detection
- Sensitivity
 - <30 mK
- Photo & Video Capability



<https://www.flir.com/products/k65/>

58

Flir K75

- Decision Making
- Field of View - 53°V x 40°H
- Resolution – 320 x 240
- Hertz (Hz) – 30
- Thermal Palette(s) –
 - TI Basic, Search, Heat Detection, High Heat, White Hot
- Sensitivity
 - <60 mK
- Photo, Video, & Streaming Capability



https://www.flir.com/products/k75/?srsltid=AfmBQopBv1M80w-geemIdeaIT_SPl600Z4nraITVY2kaUUERaYCs

59

Flir K85

- Decision Making
- Field of View - 53°V x 40°H
- Resolution – 640x480
- Hertz (Hz) – 30
- Thermal Palette(s) –
 - TI Basic, Search, Heat Detection, High Heat, White Hot
- Sensitivity
 - <60 mK
- Photo, Video, & Streaming Capability



https://www.flir.com/products/k85/?srsltid=AfmBQocfajRPh8xhRNM54Bw9T_VaaQbJrMG4KID1ePP3ZuEIQJAY

60

Scott V 320

- Decision Making
- Field of View - 55°x42°
- Resolution – 320x240
- Hertz (Hz) – >25 (9 available)
- Thermal Palette(s) – WH
- Sensitivity
 - <70 mK<100
- Mixed-Gain



https://www.3m.com/3M/en_US/p/d/b5005232016/

61

Scott 380N

- Decision Making
- Field of View - 54°
- Resolution – 384x288
- Hertz (Hz) – 50
- Thermal Palette(s) – ?
- Sensitivity
 - <50 mK
- Tri-Gain
 - H – Cold Temps
 - M - >150 °F
 - L (1000+) – Full Field of View >475° F or crosshair




<https://sos-safety.com/shop/x380-thermal-imager-three-button/>

62

ISG 380

- Decision Making
- Field of View - 54°
- Resolution – 384x288
- Hertz (Hz) – 50
- Thermal Palette(s) – ?
- Sensitivity
 - <50 mK
- Tri-Gain
 - H – Cold Temps
 - M - >150 °F
 - L (1000+) – Full Field of View >475° F or crosshair



chrome:extension://efaidnbmninnkpgcldeifndmkaj/https://inspectapedia.com/home_inspection/ISG-X380-Infrared-Camera-Manual.pdf

63

MSA 5600

- Awareness
- Field of View - 41°V x 41°H
- Resolution – 120x120
- Hertz (Hz) – 30
- Thermal Palette(s) –
 - WH
- Sensitivity
 - High – <85 mK
 - Low – <350 mK
 - Switches @32% image in high sense mode



chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://media.msanet.com/www/Product_Launch_Kits/Evolution5600/3400-82_Evo5600Specs.pdf

64

MSA 5800

- Decision Making
- Field of View - 27°V x 36°H
- Resolution - 320x240
- Hertz (Hz) – 60???
- Thermal Palette(s) –
 - WH, BH, F&I, Fusion, Rainbow
- Sensitivity
 - High – <65 mK
 - Low – <240 mK
 - Switches @32% image in high sense mode



chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://s7d9.sc.ene7.com/is/content/minesafetyappliances/EVOLUTION%205800%20bulletin%20-%20EN

65

MSA 6000 (+)

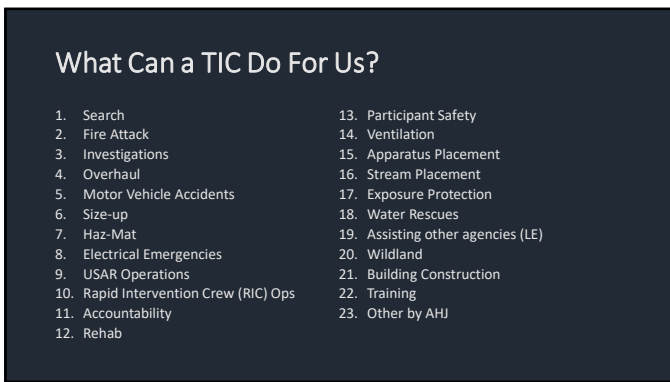
- Decision Making
- Field of View - 27°V x 36°H
- Resolution - 320x240
- Hertz (Hz) – 60???
- Thermal Palette(s) –
 - WH, BH, Rain, Iron Bow, S&R, F&I (up to 8)
- Sensitivity
 - High – <40-<78 mK
 - Low – <234 mK
 - Switches @32% image in high sense mode
 - Low Sensitive color ~1000° F



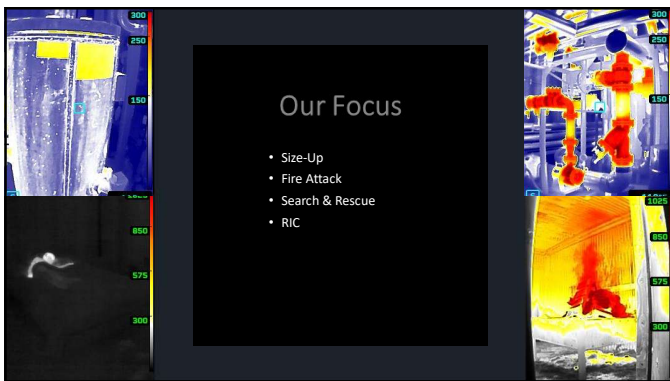
66



67



68



69

Using a Thermal Imager

- Foundation lies in firefighting basics
- TAKE IT WITH YOU!
- TIC Failed to be Deployed in 38% LODDs Whitty, 2010
- Let it warm up.
- Scan appropriately



70

Size-Up

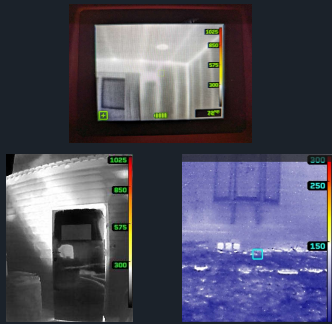
- Low to High
- Use Appropriate Speed
 - For the imager
 - For your eyes
 - For your recognition
- Complete the Scans
 - Don't stop at first color
- Choose the angle
 - Imagers see in cone through line of sight
 - Change your "line of sight"



71

Size-Up

- Conduction
 - "Thermal Bridging" = effects
 - Glass
 - Low "E" vs Single Pane
 - Uncoated glass = .84
 - Low E = < .14
- Convection
- Radiation
- Which "Mode" Should I Use?????



72



73



74

Mayday Communications Clues — FireHouse Magazine, Feb 1, 2018

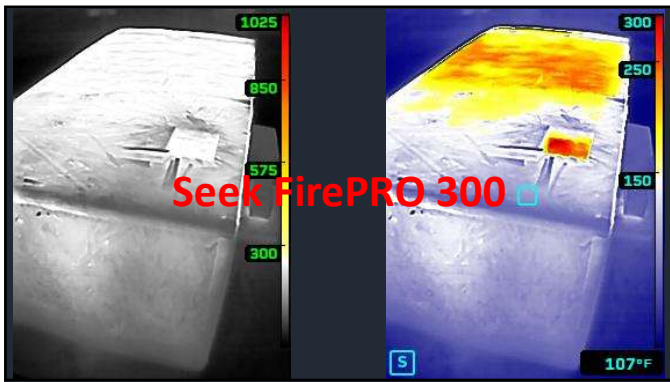
1. "We have zero-visibility conditions." — 59%
2. "We have fire above our heads." — 81%
3. "We have fire below us." — 56%
5. "We have not found the seat of the fire." — 67%
7. "This is a hoarder structure." — 54%
8. "We have had a flashover." — 37%

75

Mayday Communications Clues – FireHouse Magazine, Feb 1, 2018

- 9. "We have had a ceiling/roof collapse." – 37%
- 10. "We have lost multiple windows." – 29%
- 11. "It's really getting hot in here; we are backing out." – 44%
- 12. "Our exit has been blocked." – 21%
- 14. "We have a hole in the floor" or "we have had a floor collapse." – 56%

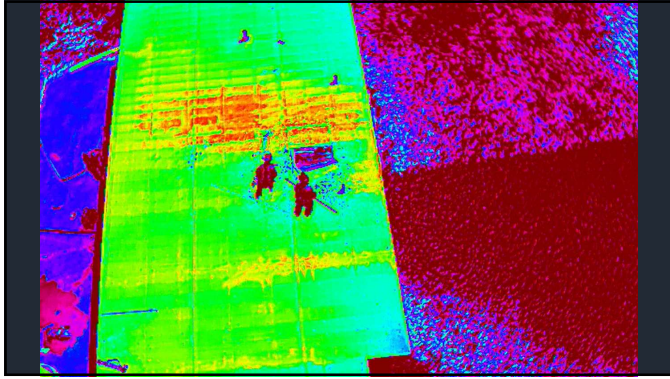
76



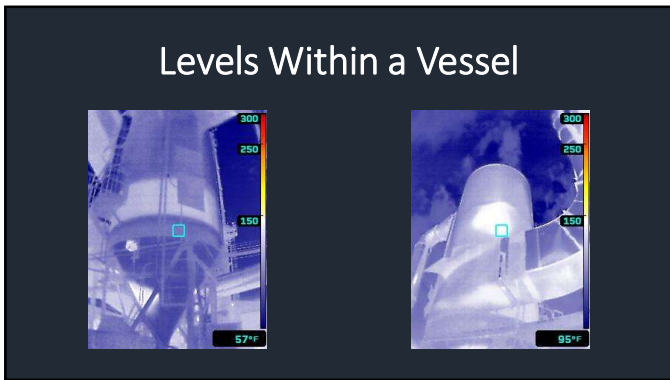
77



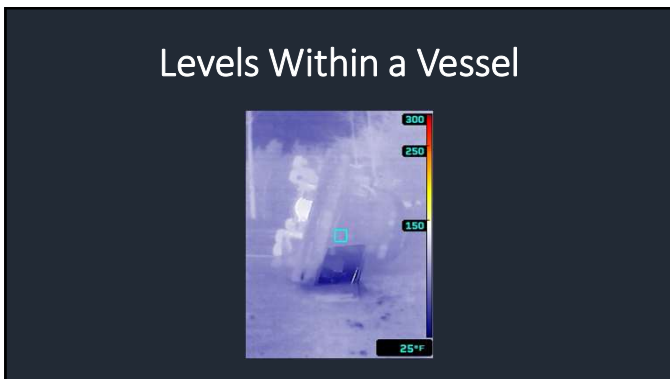
78



79



80



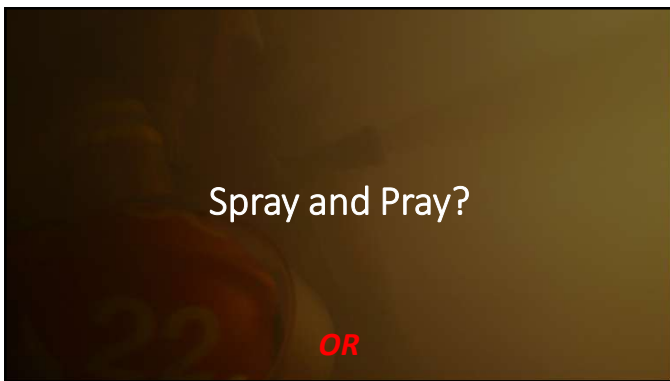
81



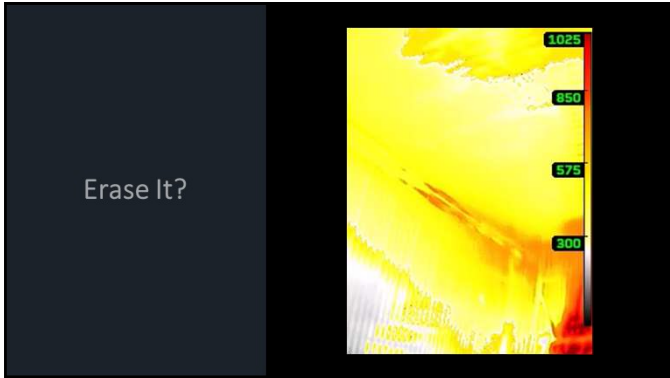
82



83



84



85



86

Should we "feel" the heat?

- Sensing Heat
- 20kW/m² Heat Release Rate

	Thickness	Time to Hole
• NFPA 1981 – 2007 Edition SCBA mask	= 2.2mm	=1:50
• NFPA 1981 – 2007 Edition SCBA mask with new geometry	= 2.6mm	=1:54
• NFPA 1981 – 2013 Edition SCBA Mask	= 4.1mm	=6:59

- @ 446°F Polycarbonate melts
- Begins to degrade @ ~350°F @ 12kW/m²
- (NOTE: Thermal insult was seen at lower HRR. See the study for more information.)

Madrzykowski, D. & Kesler, R. 2023

OR

87

SCBA Facepiece (Mfg- NFPA ED)	Description	Mass (g)	Thickness (mm)
1-07A	Meets NFPA 1981-2007 edition, older geometry	124	2.2
1-07B	Meets NFPA 1981-2007 edition, updated geometry	143	2.6
1-13	Meets NFPA 1981-2013 edition	167	4.1

TABLE 1
SCBA facepiece models utilized in UL's Fire Safety Research Institute's study of SCBA facepieces that were exposed to thermal conditions.

88

		5 kW/m ²	10 kW/m ²	15 kW/m ²	20 kW/m ²
Crazing	1-07A	19:20*	1:16 (0-16)	0:43 (0-07)	0:31 (0-04)
	1-07B	8:19 (1-51)	1:20 (0-05)	0:57 (0-11)	0:42 (0-11)
	1-13		3:49 (0-30)**	1:39 (0-06)**	1:04 (0-07)**
Bubbling	1-07A		2:37 (0-11)	1:14 (0-07)	0:56 (0-03)
	1-07B		2:05 (0-30)	1:15 (0-17)	0:58 (0-04)
	1-13		8:13 (2-06)**	2:38 (0-11)**	1:34 (0-01)**
Hole Formation	1-07A			4:44 (2-54)	1:50 (0-05)
	1-07B			3:11 (0-35)	1:54 (0-06)
	1-13		13:26 (4-17)		6:59 (0-40)**

TABLE 2
Time to thermal degradation by mask type and heat flux. All times reported in minutes and seconds.
* Indicates significant difference between 1-07A and 1-07B.
** Indicates that 1-13 is significantly different from 1-07A and 107B.

89



90

7 Color/Temperature Associations in Firefighting Mode

Cold	HOT	392 Degrees Fahrenheit	665 Degrees Fahrenheit	932 Degrees Fahrenheit	1247 Degrees Fahrenheit	1562 Degrees Fahrenheit
Subjective	Subjective	SCBA Face piece Lens nearing Failure Temperature	Nomex Hoods Char & Burn at 572 Degrees Fahrenheit	Lean Flashover is occurring, Fire Gas Ignitions, Rollover, And PBI outer shell begins to fail	Flashover occurred, injury and death.	SCBA bottle failure

INSIGHT FIRE TRAINING Extreme → Critical → Death

https://twitter.com/KTFBurnsDC/status/1679264424941502465

91

2021 NFPA 1700 – Guide For Structural Firefighting

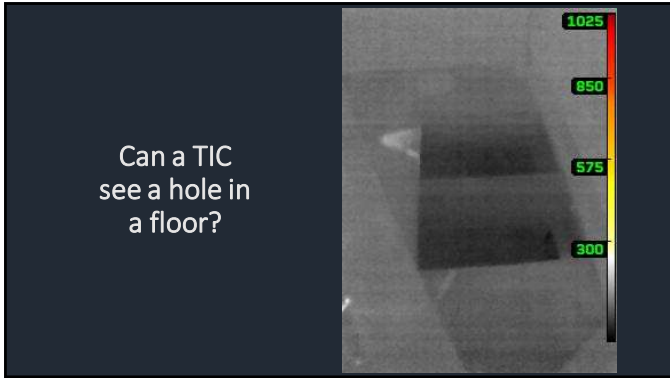
- 8.9 Thermal Imager — TIC (NFPA 1801).
- See 8.8.2, “Heat and Flame Test” (203°F (95°C) convective oven for 15 minutes followed by 10 second direct flame contact) and 8.7.2, “Elevated Heat and Flame Resistance Test” (convection oven at 500°F (260°C) for 5 minutes).

92

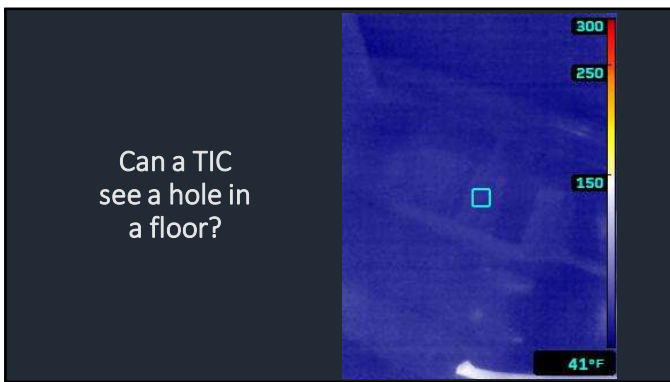
Fire Attack with a TIC

- <https://www.youtube.com/watch?v=CvivAWIDjsc>

93



94



95



96

Search & Rescue

- What is arguably the single most important factor in search and rescue?



97

Search & Rescue

Should THEY “feel” the heat?

- “There is clear evidence that the perception of pain in adult human skin occurs just above 43 °C. When the basal layer of the epidermis reaches 44 °C, burn injury occurs.” — Science Direct
 - 43°C = 109.4°F = Skin feels pain from a burn
 - 44°C = 111.2°F = Burn Injury
- **60°C = 140°F for 5 seconds = Third Degree burn involving nerves**

NIST Data - <https://www.nist.gov/thermal-characterization/12200/thermal-service-fire-dynamics>

98

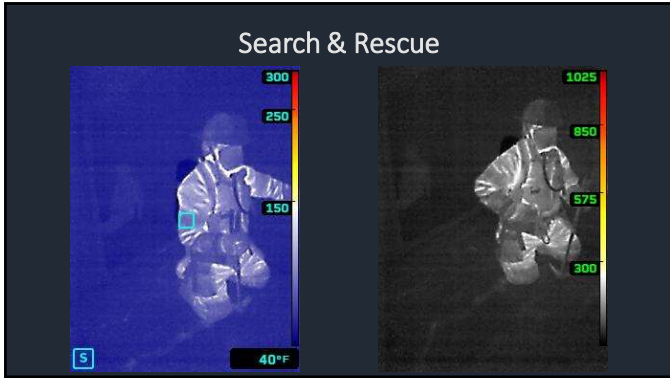
Search & Rescue Training



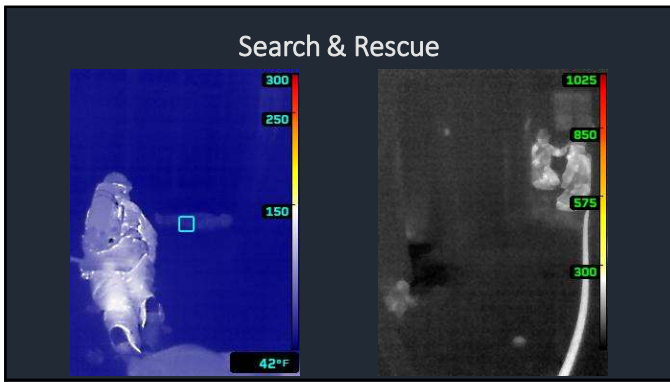
Are you training in limited to no-vis?

Are you able to see to assess them?

99



100



101



102



103

1999 Fire-Rescue Magazine Study

- 60 Test Burns
- Without an Imager
 - “60% of the time, firefighters missed the victim”
- WITH an IMAGER
 - “99% of the time firefighters FOUND the victim”
- “The time required to satisfactorily complete a search with a thermal imager dropped by 75%.”

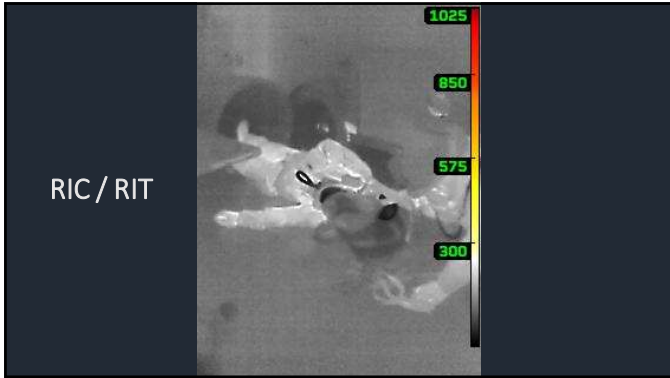
104

Firefighter Rescue Survey

1200
900
600
300

82 F

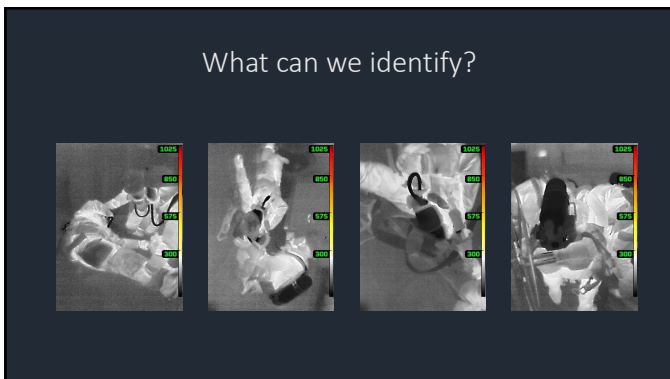
105



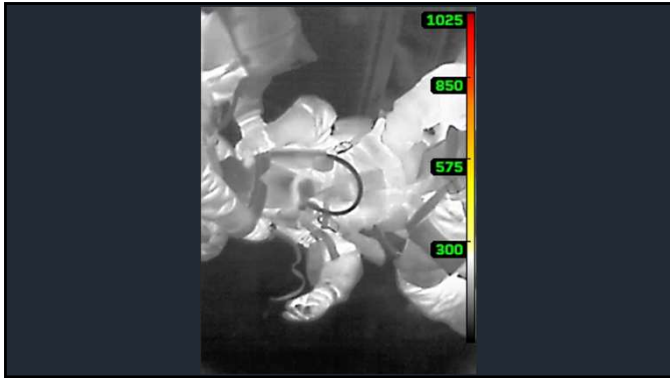
106



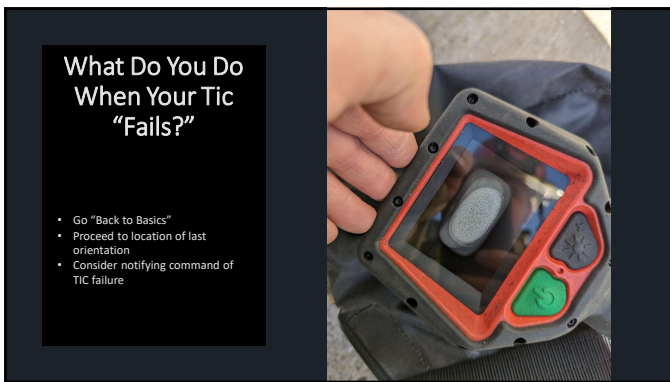
107



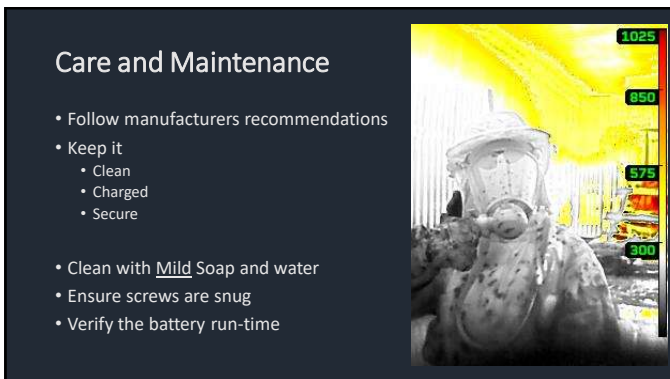
108



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Demonstrations / Drills

- Station "Tour"
- Depth Perception
- Size-Up
- TIC in cold smoke (theater)
- Search and Rescue
- TIC Failure
- TIC with Fire Box
- TIC with 1403-Burn

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Tips From Andy Starnes

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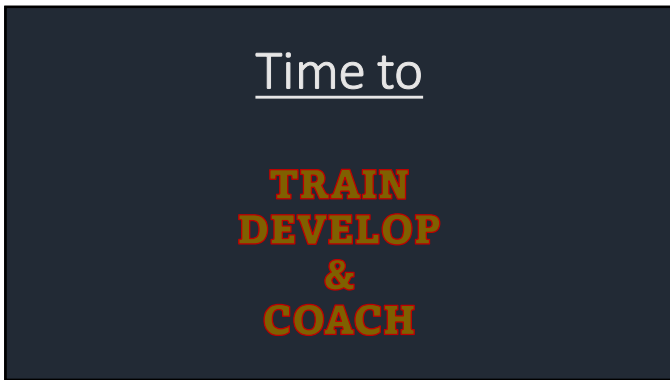
The Firefighter Rescue Survey

- Voluntary information gathering tool for firefighters nationwide.
- Making our metrics match our mission.
- www.firefighterrescuesurvey.com

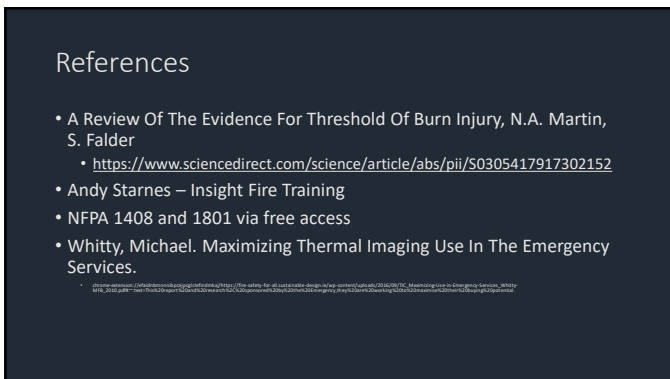
114



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References

- Firehouse Presents Thermal Imager Survey Results
 - <https://www.firehouse.com/sponsored-content/document/21158436/firehouse-presents-thermal-imager-survey-results>
- Madrzykowski, D. & Kesler, R. Research Corner: Thermal Performance of SCBA Facepieces Exposed to Radiant Heat. February 6, 2023.

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QUESTIONS?

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Thank you!



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